

МАКЕДОНСКО ГЕОЛОШКО ДРУШТВО

ТРЕТ КОНГРЕС

на

Геолозите на Република Македонија

**ЗБОРНИК НА ТРУДОВИ**

**-КНИГА 2-**



**Уредници:**

Лепиткова, С. & Боев, Б.

*Струга, 2016*

*Посебно издание на  
Geologica Macedonica, № 4*

МАКЕДОНСКО ГЕОЛОШКО ДРУШТВО

ТРЕТ КОНГРЕС  
на  
Геолозите на Република Македонија

# ЗБОРНИК НА ТРУДОВИ

-КНИГА 2-

*Уредници:*  
Лепиткова, С. & Боев, Б.

Струга, 2016

**Издавач:** Македонско геолошко друштво

**Главни и одговорни уредници:** Проф. д-р Соња Лепиткова и  
Проф. д-р Блажо Боев

**Уреднички одбор:** Проф. д-р Тодор Серафимовски (Р.Македонија), Проф. д-р Блажо Боев (Р.Македонија), Acad. Prof. Vladimir Bermanec PhD (Croatia), Акад. проф д-р Владица Цветковиќ (Србија), Acad. prof. Ivan Zagorchev PhD (Bulgaria), Prof. Tadej Dolenec PhD (Slovenia), Prof. David Alderton PhD (Great Britain), Prof. Wolfgang Todt PhD (Germany), Акад. проф. д-р Николај С. Бортников (Русија), Prof. Clark Burchfield PhD (USA), Prof. Thierry Auge PhD (France), Проф. д-р Тодор Делипетров (Р.Македонија), Проф. д-р Милорад Јовановски (Р.Македонија), Проф. д-р Споменко Михајловиќ (Србија), Проф. д-р Драган Миловановиќ (Србија), Проф. д-р Дејан Прелевиќ (Germany), Prof. Albrecht von Quadt (Switzerland) PhD.

**Технички уредник:** Доц. д-р Игор Пешевски

**Печати:** Печатница "2-ри Август С" -Штип

**Тираж:** 300 примероци

## Организационен одбор на Третиот Конгрес на Геолозите на Република Македонија

**Претседател:** Проф. д-р Соња Лепиткова  
**Секретар:** д-р Златко Илијовски

**Технички секретар:** Доц. д-р Игор Пешевски

**Членови:** Проф. д-р Блажо Боев  
Проф. д-р Тодор Серафимовски  
Проф. д-р Милорад Јовановски  
Проф. д-р Орце Спасовски  
Проф. д-р Војо Мирчовски  
д-р Коста Јованов  
м-р Флорент Чиче  
Кирил Филев

### Финансиска поддршка:

ДПТУ „Бучим“ ДОО-Радовиш  
АДОРА ИНЖЕНЕРИНГ ДООЕЛ – Скопје  
Рудник “САСА” ДООЕЛ – Македонска Каменица  
Градежен Институт „Македонија“ АД – Скопје  
ГЕИНГ Кребс унд Кифер Интернешнл и др. ДОО – Скопје  
„Мермерен комбинат“ АД – Прилеп  
Простор ДОО – Куманово  
„Геохидроконсалтинг“ ДООЕЛ – Скопје  
„Геохидроинженеринг“ ДООЕЛ – Скопје  
Хидроинженеринг ДООЕЛ– Битола  
Градежен факултет – Скопје, Катедра за геотехника  
„ГЕОМАП“ ДОО – Скопје  
БУЛМАК ГРУП ДООЕЛ – Скопје  
ЕУРОМАКС РЕСОУРЦЕС ДОО – Скопје  
САРДИЧ МЦ ДООЕЛ – Скопје  
МАРКОВСКИ КОМПАНИ БОРЧЕ ДООЕЛ – Битола  
DIWI Македонија ДООЕЛ – Скопје  
ВАРДАРГРАДБА ДОО – Скопје



## ПРЕДГОВОР

Геологијата како природна фундаментална наука има незаменливо значење за општеството и е оној камен темелник на кој се засновани голем број гранки од инженерството и индустријата.

Нејзиното значењето кај нас е многу јасно препознаено уште во далечната 1944 година, кога со одлука на Президиумот на АСНОМ е формиран Геолошкиот институт на НРМ, прва македонска геолошка институција.

Денес Македонското геолошко друштво како еден од главните промотори на геолошката наука во нашата земја, е пред нов предизвик, организирањето на Третиот Конгрес на геолозите на Република Македонија.

Организациониот и Научниот одбор на Третиот Конгрес, имајќи ја предвид долгата традиција на геолошката наука, но истовремено согледувајќи го актуелниот момент, одлучија носечките теми на Конгресот да бидат поврзани со:

- Геологијата и општеството,
- Фундаменталната геологија и
- Геологијата и економијата.

За овие теми во овој Зборник се публикувани вкупно 105 оригинални научни трудови, кои се подготвени од преку 350 автори и коавтори од поголем број на земји. Низ трудовите се елаборирани резултати од вредни и долготрајни истражувања на нашите и странските инженери и научни работници.

Од пристигнатите трудови може да се забележи поврзаноста на традиционалните истражни методи и примената на нови современи технологии и алатки при геолошките проучувања, вклучувајќи најсовремени теренски и лабораториски инструментални методи, системи за обработка, чување на податоци и следење на параметрите на животната средина. Се надеваме, дека прикажани ставови, размислувања и резултати ќе ги зацврстат досегашните знаења, и ќе се поттикнат идеи за значајни нови истражувања.

Затоа, Организациониот одбор искрено им се заблагодарува на сите автори, учесници и помагачи на Конгресот, кои сите заедно со пожртвуваноста овозможиле овој Зборник да биде нешто со кое сите ќе се гордееме.

## PREFACE

Geology as a natural and fundamental science is of great importance for the society and it is the foundation of many engineering and industry branches.

Its' importance in our country was clearly recognized in 1994, when the presidium of ASNOM reached a decision to establish a Geological institute of NRM, the first Macedonian geological institution.

Nowadays, the Macedonian geological society as one of the main promoters of the geological science in our country, has accepted a new challenge, the organization of the Third Congress of Geologists of Republic of Macedonia.

The Organizing and scientific committees of the Third congress, given the long tradition of the geological science, at the same time looking at its' current state, has decided that the main topics of the Congress are related to:

- Geology and society
- Fundamental geology and
- Geology and economy

There is a total of 105 original scientific papers published in these Proceedings, prepared by over 350 authors and coauthors from number of countries for these proceedings. Results from valuable and long investigations of our and the foreign engineers and scientific workers have been elaborated through the papers.

From the papers, it could be noted that there is a strong connection between the traditional investigation methods and the new contemporary technologies and tools in geological explorations, including the latest field and laboratory instrumental methods, systems for processing and data storage, and monitoring environmental parameters. We hope that, the presented views, considerations and results will strengthen the existing knowledge, and will encourage ideas for new significant research.

Therefore, the Organizing Committee would like to sincerely thank all the authors, participants and supporters of the Congress, who along with their devotion helped making us all proud of this Proceedings book.

**Претседател  
на Организационен  
Одбор**

**President  
of Organizing  
Committee**

Проф. д-р Соња Лепиткова

# КНИГА 1

## СОДРЖИНА

## CONTENTS

### 1. Геологијата и Општеството

КЛИМАТСКИТЕ ПРОМЕНИ И ДОКАЗИТЕ ВО ГЕОЛОШКИТЕ ЗАПИСИ НА ПРИМЕРИТЕ НА НАЈГОЛЕМИТЕ МАСОВНИ УНИШТУВАЊА НА ВРСТИТЕ (Р-Т ГРАНИЦА, К-Т ГРАНИЦА) <i>Блажо Боев</i>	.....	1
ГЕОЛОШКИ ЗАВОД НА РЕПУБЛИКА МАКЕДОНИЈА <i>Костадин Јованов</i>	.....	17
СОСТОЈБА И НАТАМОШЕН РАЗВОЈ НА ОСНОВНИТЕ ГЕОЛОШКИ ИСТРАЖУВАЊА ВО РЕПУБЛИКА МАКЕДОНИЈА <i>Новица Столиќ</i>	.....	23
РЕАЛИЗАЦИЈА НА ГЕОПРОСТОРНИ МРЕЖНИ УСЛУГИ ВО РАМКИТЕ НА ГЕОИНФОРМАЦИОНИОТ СИСТЕМ НА ГЕОЛОШКИОТ ЗАВОД НА РЕПУБЛИКА МАКЕДОНИЈА <i>Лука Јовичиќ</i>	.....	33
THE METHODOLOGY AND CONCEPTION OF DEVELOPING GEOLOGICAL MAP (GK-50) OF REPUBLIC SERBIA AND SYNTHESIS OF GEOLOGICAL FORMATIONS AFTER FINISHED SHEETS <i>Rodoljub Gajić, Divna Jovanović, Dejan Barjaktarović, Petar Stejić, Mihailo Pandurov</i>	.....	43
ПОДЕЛБА И НОМЕНКЛАТУРА НА ОСНОВНИТЕ ГЕОЛОШКИ КАРТИ НА РЕПУБЛИКА МАКЕДОНИЈА <i>Новица Столиќ</i>	.....	47
ТРАНСФОРМАЦИЈА НА ОДНОСОТ ПОМЕЃУ ГЕОИНЖЕНЕРИТЕ И ДОНОСИТЕЛИТЕ НА ОДЛУКИ ПРИ УРБАНОТО ПЛАНИРАЊЕ (COST ACTION TU1206 SUB-URBAN) <i>Игор Пешевски, Diarmad Campbell, Милорад Јовановски</i>	.....	55
INTERPRETING GROUNDWATER CHARACTER FROM FLOOD PULSES AND ARTIFICIAL TRACER TEST-A CASE STUDY OF THE SLATINSKI IZVOR SPRING (REPUBLIC OF MACEDONIA) <i>Biljana Gičevski, Metka Petrič, Janja Kogovšek</i>	.....	67

CROSS-CORRELATION ANALYSES OF KARST SPRING DISCHARGES	
<i>Marina Čokorilo Ilić, Vesna Ristić Vakanjac, Saša Milanović, Ljiljana Vasić, Kostadin Jovanov, Radisav Golubović</i>	77
AUTOCORRELATION ANALYSES OF KARST SPRING DISCHARGE REGIMES	
<i>Vesna Ristić Vakanjac, Saša Milanović, Marina Čokorilo Ilić, Kostadin Jovanov, Ljiljana Vasić</i>	85
ИЗРАБОТКА НА АЖУРИРАНА ХИДРОГЕОЛОШКА КАРТА НА МАКЕДОНИЈА 1 : 300 000	
<i>Златко Илијовски</i>	93
DETERMINATION OF SUBSURFACE THERMAL PROPERTIES FOR HEAT PUMP UTILIZATION IN CROATIA	
<i>Staša Borović, Kosta Urumović, Josip Terzić</i>	105
ХИДРОГЕОЛОШКИ ИСТРАЖНИ РАБОТИ НА ПОДЗЕМНА ВОДА И ИЗВЕДБА НА БУНАРСКИ СИСТЕМ ЗА ПОТРЕБИ НА СИСТЕМОТ ЗА КЛИМАТИЗАЦИЈА НА ОБЈЕКТОТ „НОВА БОЛНИЦА ФИЛИП ВТОРИ“ – СКОПЈЕ	
<i>Стојан Михаиловски, Златко Илијовски</i>	111
ХИДРОГЕОЛОШКИ КАРАКТЕРИСТИКИ И ПРОГНОЗА НА ПРИЛИВ НА ВОДИ ВО РУДНИК ЗА ЈАГЛЕН „СУВОДОЛ“-БИТОЛА	
<i>Костадин Јованов, Весна Ристик Вакањац</i>	121
ЗАШТИТА НА РУДНИКОТ ЗА ПОВРШИНСКА ЕКСПЛОАТАЦИЈА „БРОД - ГНЕОТИНО“ ОД ПОДЗЕМНИ ВОДИ	
<i>Розета Јанкова, Сандо Донеv, Александар Мурџовски</i>	127
ХИДРОГЕОЛОШКИ КАРАКТЕРИСТИКИ НА ПОЛИМЕТАЛИЧНОТО НАОЃАЛИШТЕ ЛУКЕ - КРИВА ПАЛАНКА	
<i>Ласте Ивановски, Војо Мирчовски, Ѓорѓи Димов, Виолета Стефанова, Силвана Пешовска</i>	135
ИСТРАЖУВАЊА НА ПЕТРОТЕРМАЛНА ЕНЕРГИЈА НА ЛОКАЛИТЕТОТ КРАТОВСКО ЗЛЕТОВСКА ОБЛАСТ	
<i>Силвана Пешовска, Новица Столик, Димитар Петров, Маринко Ефтимов</i>	145
СЛЕДЕЊЕ НА КВАЛИТЕТОТ НА ПОВРШИНСКИТЕ ВОДИ ВО ОКОЛИНАТА НА ИДНИОТ РУДНИК „ИЛОВИЦА-ШТУКА“	
<i>Драги Пелтечки, Вера Ѓоргиева, Теодора Стојанова, Љубица Панова</i>	155

ХИДРОГЕОЛОШКИ ИСТРАЖУВАЊА ЗА ОБЕЗБЕДУВАЊЕ НА ПОТРЕБНИТЕ КОЛИЧИНИ НА ПОДЗЕМНА ВОДА ЗА ВОДОСНАБДУВАЊЕ НА СЕЛЮ ОРЕЛ, ОПШТИНА СВЕТИ НИКОЛЕ <i>Орце Спасовски, Даниел Спасовски</i>	163
SAMPLING AND CHARACTERIZATION OF RIVERINE SUSPENDED PARTICULATE MATERIAL (SPM): THE SAVA RIVER (CROATIA) <i>Neda Vdović, Mavro Lučić, Niko Bačić, Nevenka Mikac</i>	169
BIOACCESSIBILITY AND BIOAVAILABILITY OF POTENTIALLY TOXIC ELEMENTS IN HEALING MUD <i>Hana Fajković, Esad Prohić, Ivan Nemet, Sanda Rončević, Dražen Kurtanjek, Ana Rosandić</i>	171
МОНИТОРИНГ НА ПОДЗЕМНИТЕ ВОДНИ ТЕЛА ВО РЕЧНИОТ СЛИВ НА РЕКА БРЕГАЛНИЦА <i>Розета Јанкова, Сандо Донеv</i>	173
ХИДРОГЕОЛОШКИ ИСТРАЖУВАЊА ЗА ОБЕЗБЕДУВАЊЕ НА ПОДЗЕМНА ВОДА ЗА ПОТРЕБИТЕ НА „СКИ ЦЕНТАР ВОДНО“ <i>Никола Димов, Марко Марков, Владимир Костовски</i>	183
LEVEL CHANGE IN VRGORAC LAKE - RESULT OF NEOTECTONIC SUBSIDENCE AND INTENSIVE SEDIMENT EROSION <i>Hrvoje Posilović, Lidija Galović</i>	189
VERIFICATION OF CATCHMENT SIZE USING THE WATER BALANCE EQUATION <i>Vesna Ristić Vakanjac, Veljko Marinović, Zoran Nikić, Dušan Polomčić, Marina Čokorilo Ilić, Dragoljub Bajić</i>	191
FROM LANDSLIDE INVENTORY TO LANDSLIDE RISK ASSESSMENT: METHODOLOGY, CURRENT PRACTICE AND CHALLENGES <i>Miloš Marjanović, Uroš Đurić</i>	199
ВЛИЈАНИЕТО НА СВЛЕЧИШТАТА ВО ПК “СУВОДОЛ”- МИКРОЛОКАЦИЈА 7 НА КВАЛИТАТИВНИТЕ ПАРАМЕТРИ НА ПРЕОСТАНАТИОТ ЈАГЛЕН ВО ИСТОИМЕНАТА МИКРОЛОКАЦИЈА <i>Љупчо Петрески, Анита Мартиновиќ, Елизабета Митревска</i>	209
DATA ABOUT LANDSLIDES: ACQUISITION, EDITING, USABILITY AT GEOLOGICAL SURVEY OF SLOVENIA <i>Špela Kumelj</i>	217

THE PREVENTIVE AND URGENT ACTIVITIES TO AVOID LANDSLIDE CONSEQUENCES - CASE STUDY OF VOGOSCA MUNICIPALITY DURING THE PERIOD OF FLOODS IN BOSNIA AND HERZEGOVINA IN MAY 2014-	223
<i>Toni Nikolić, Jasminka Nikolić</i>	
ENGINEERING GEOLOGICAL MODEL OF LANDSLIDE DRAGODAN	229
<i>Željko Miklin, Kosta Urumović, Josip Terzić, Josip Halamić, Tomislav Novosel</i>	
REMEDIATION OF SMALL LANDSLIDES AS EMERGENCY MEASURES FOR THE PRESERVATION OF STABILITY OF THE TERRAIN	237
<i>Nedjo Djuric, Dijana Djuric</i>	
POTOŠKA PLANINA LANDSLIDE (NW SLOVENIA)	243
<i>Tina Peternel, Marko Komac</i>	
САНАЦИЈА НА ОДРОНЕТ ДЕЛ ОД ТУНЕЛ „ПРЕСЕКА“ НА СТАЦ. КМ 20+250, ДЕЛ ОД АВТОПАТ КИЧЕВО- ОХРИД	249
<i>Моце Милановски, Стојанче Николов, Антонио Костов, Бојан Јаневски</i>	
ОСИГУРУВАЊЕ НА НЕСТАБИЛЕН БЛОК НАД ЗАТВАРАЧНИЦА НА ХЕЦ „СВЕТА ПЕТКА“	259
<i>Моце Милановски, Бојан Јаневски, Ацо Велевски</i>	
ЗНАЧЕЊЕ НА ИНЖЕНЕРСКОГЕОЛОШКИТЕ КАРАКТЕРИСТИКИ И ГЕОТЕХНИЧКИ УСЛОВИ ЗА ИЗВЕДБА НА КОСИНИ	265
<i>Орце Петковски, Ванчо Ангелов, Ласте Ивановски</i>	
ИНЖЕНЕРСКО-ГЕОЛОШКИ КАРАКТЕРИСТИКИ НАТЕРЕНОТ НА ВОДОЗАФАТОТ ЗА ИЗГРАДБА НА МАЛАХИДРОЕЛЕКТРИЧНА ЦЕНТРАЛА НА КЛЕПАЛСКА РЕКА – БЕРОВО	273
<i>Соња Паунова, Војо Мирчовски, Ѓорѓи Димов</i>	
ФИЗИЧКО - МЕХАНИЧКИ КАРАКТЕРИСТИКИ КАЈ ПОЗНАЧАЈНИ НАОЃАЛИШТА НА ГРАДЕЖНО - ТЕХНИЧКИ КАМЕН ВО РЕПУБЛИКА МАКЕДОНИЈА	283
<i>Љупче Ефнушев, Зоран Панов, Ѓорѓи Димов</i>	
СТЕРЕОГРАФСКА АНАЛИЗА НА ПЛАНАРНИТЕ И РУПТУРНИТЕ СТРУКТУРИ НА ИСТОЧНОТО КРИЛО НА БРЖДАНСКАТА АНТИКЛИНАЛА ВРЗ ОСНОВА НА ГЕОТЕХНИЧКИТЕ ИСТРАЖУВАЊА ЗА ЖЕЛЕЗНИЧКА ПРУГА, КОРИДОР VIII, ДЕЛНИЦА КИЧЕВО – ЛИН (Р. АЛБАНИЈА)	289
<i>Игор Митев, Александар Мурџовски, Сашо Георгиевски</i>	

## 2. Фундаментална Геологија

GEOCHRONOLOGICAL DATA FROM SOME CAVES IN MACEDONIA AND THEIR CONTRIBUTION TO THE UNDERSTANDING OF THE REGIONAL GEOLOGICAL EVOLUTION <i>Marjan Temovski</i>	297
ОДРЕДУВАЊЕ НА АПСОЛУТНАТА СТАРОСТ НА МАГМАТСКИТЕ КАРПИ ОД ОГРАЖДЕНСКИОТ МАСИВ <i>Емил Петрушев, Новица Столиќ</i>	307
LITHO-, BIO- AND CHEMOSTRATIGRAPHIC METHODS IN STRATIGRAPHY: SOME EXAMPLES FROM THE DINARIDES (CROATIA AND SLOVENIA) <i>Dunja Aljinović, Tea Kolar-Jurkovšek, Bogdan Jurkovšek, Duje Smirčić</i>	313
POSTOROGENIC INTERPLAY OF TECTONIC AND MAGMATIC PROCESSES WITHIN THE INTERNAL DINARIDES <i>Ana Mladenović, Vladica Cvetković, Branislav Trivić</i>	317
CHARACTERISTICS OF MIDDLE TRIASSIC VOLCANICLASTIC DEPOSITS IN THE EXTERNAL DINARIDES (CROATIA AND BOSNIA AND HERZEGOVINA) <i>Duje Smirčić, Dunja Aljinović, Vesnica Garašić, Tea Kolar- Jurkovšek, Uroš Barudžija, Hazim Hrvatović, Bogdan Jurkovšek</i>	319
VOLCANOLOGY OF KOZUF MOUNTAIN IN THE REPUBLIC OF MACEDONIA <i>Blazo Boev, Ivan Boev, Sonja Lepitkova</i>	323
SEDIMENTOLOGY AND BIOSTRATIGRAPHY OF THE CAMPANIAN-MAASTRICHTIAN CALCICLASTIC TURBIDITIES FROM THE LJIG AREA (CENTRAL PART OF THE VARDAR ZONE) <i>Violeta Gajić, Milena Dunčić, Nebojša Vasić, Vladislav Gajić</i>	335
RECONSTRUCTION OF PALAEOENVIRONMENT DURING QUATERNARY SEDIMENTATION IN THE VRGORAČKO POLJE <i>Lidija Galović, Hrvoje Posilović, Petar Stejić, Mihajlo Pandurov, Rodoljub Gajić</i>	339
A MONOSPECIFIC ASSEMBLAGE OF A NEW GIANT RHYNCHONELLIDE BRACHIOPOD FROM THE MIDDLE JURASSIC OF EASTERN SERBIA <i>Barbara V. Radulović, Michael R. Sandy, Wagih Ayoub-Hannaa, Peter Schaaf, Vladan J. Radulović</i>	343



PALEOECOLOGICAL CHARACTER OF ASIAN CLAMS IN ESTIMATES OF THE ANTHROPOGENOUS EFFECT ON RECENT ECOSYSTEMS <i>Barbara Radulović, Draženko Nenadić, Slobodan Knežević, Momir Paunović, Katarina Bogićević</i>	.....	347
SQUAMATE REMAINS FROM THE EARLY AND MIDDLE PLEISTOCENE SREM SERIES IN THE MUTALJ QUARRY (BEOČIN, NORTHERN SERBIA) <i>Dragana Đurić, Katarina Bogićević, Draženko Nenadić</i>	.....	351
SMALL MAMMALS FROM THE VELIKA AND MALA BALANICA CAVES (NIŠ, SOUTHERN SERBIA) <i>Katarina Bogićević, Draženko Nenadić, Dušan Mihailović</i>	.....	357
ФОРАМИНИФЕРНА ФАУНА ОД ПАЛЕОГЕНИТЕ СЕДИМЕНТИ НА ТЕРИТОРИЈАТА НА РЕПУБЛИКА МАКЕДОНИЈА <i>Виолета Стојанова, Гоше Петров, Крсто Блажев</i>	.....	361

## КНИГА 2

### СОДРЖИНА

### CONTENTS

## 2. Фундаментална Геологија

PETROLOGICAL CHARACTERISTICS OF CLASTIC SEDIMENTARY ROCKS IN SV. BARBARA MINE IN RUDE NEAR SAMOBOR, SAMOBORSKA GORA MT. <i>Šime Bilić, Vesnica Garašić</i>	369
PETROLOGY OF GNEISSES FROM THE VRŠAC MOUNTAINS <i>Dragan Milovanović, Danica Srećković-Batočanin, Emin Memović</i>	371
МИНЕРАЛОШКО – ПЕТРОГРАФСКИ И ХЕМИСКИ КАРАКТЕРИСТИКИ НА ГРАНИТОИДНИТЕ КАРПИ ОД ЛОКАЛИТЕТОТ ПЕШТАНИ, ЗАПАДНА МАКЕДОНИЈА <i>Сашио Стојков, Даниел Спасовски, Орце Спасовски</i>	373
МИНЕРАЛОШКО-ПЕТРОГРАФСКИ И ГЕОХЕМИСКИ КАРАКТЕРИСТИКИ НА СКАРНОВИТЕ ОД НАОЃАЛИШТЕТО ИБЕРЛИ <i>Кука Шпритова</i>	379
GARNET-ANDALUSITE/SILLIMANITE-BIOTITE XENOLITHS FROM THE DACITE OF SLAVKOVICA (LJIG, SW SERBIA) <i>Nada Vasković, Danica Srećković – Batočanin, Suzana Erić, Vesna Matović</i>	389
BLADED QUARTZ TEXTURE AND ITS RELATIONSHIP TO ELECTRUM MINERALIZATION IN THE EOCENE, LOW-SULFIDATION KUKLITSA GOLD DEPOSIT, SE BULGARIA PRELIMINARY DATA <i>Irina Marinova, Elena Tacheva</i>	393
ASSOCIATION OF OXIDE MINERALS – CONCENTRATORS OF CHALCOPHILE ELEMENTS (Pb, Zn, Sb) FROM THE “MIXED SERIES” NEAR NEŽILOVO VILLAGE, MACEDONIA <i>Simeon Jancev, Nikita V. Chukanov, Vera N. Ermolaeva</i>	401
LORANDITE AND ORPIMENTE FROM EDIT-25 NORTH PART OF ALSHAR DEPOSIT <i>Ivan Boev, Blazo Boev</i>	405
NEW INVESTIGATIONS ON DUNJE PEGMATITE, MACEDONIA I: THE CONTRIBUTION TO THE KNOWLEDGE ABOUT ALKALI FELDSPARS AND ITS MINERAL PARAGENESIS <i>Vladimir Zebec, Snježana Mikulčić Pavlaković, Marin Šoufek, Blažo Boev, Ivan Boev, Vladimir Bermanec</i>	413

NEW INVESTIGATIONS ON DUNJE PEGMATITE, MACEDONIA II: RELATION TO HOST METAMORPHIC ROCKS AND ADJACENT GRANITE INTRUSIONS	
<i>Nenad Tomašić, Andrea Čobić, Blažo Boev, Ivan Boev, Vladimir Bermanec</i>	417
MOISSANITE METEORITE IN TERRITORY OF THE REPUBLIC OF MACEDONIA	
<i>Blazo Boev, Velo Markovski, Ivan Boev</i>	421
МИНЕРАЛОШКО-ПЕТРОЛОШКИ КАРАКТЕРИСТИКИ НА МИКАШИСТИТЕ ОД ОКОЛИНАТА НА С.БОНЧЕ, ПРИЛЕП	
<i>Филип Јованоски, Тена Шијакова-Иванова, Блажо Боев, Виолета Стефанова</i>	425
ИДЕНТИФИКАЦИЈА НА МИНЕРАЛИТЕ ОД НАОЃАЛИШТЕТО ЗА ОЛОВО И ЦИНК "ЗЛЕТОВО" СО ПРИМЕНА НА РЕНДГЕНСКО ДИФРАКЦИОНА МЕТОДА	
<i>Елена Наунова, Тена Шијакова-Иванова, Блажо Боев</i>	431
GEOCHEMICAL FEATURES OF SILURIAN - DEVONIAN SECTION OF PELAGONIANE ZONE IN ALBANIA	
<i>Irakli Prifti, Ilir Alliu, Agim Ymeri</i>	437
GEOMICROBIOLOGICAL OBSERVATION IN MAJDANSKA REKA, ALLCHAR, MACEDONIA	
<i>Vladimir Bermanec, Jasna Hrenović, Željka Fiket, Ladislav Palinkaš, Ivan Boev, Blažo Boev</i>	447
RADIONUCLIDES IN SOIL, MOSSES, AND MUSHROOM OF THE PRAŠNIK RAINFOREST (CROATIA)	
<i>Gordana Mednuić, Gordana Marović, Jasminka Senčar</i>	451
SCANNING ELECTRON MICROSCOPY STUDIES OF PARTICLES (PM-10) FROM THE TOWN OF KAVADARCI AND VILAGE VOZARCI, REPUBLIC OF MACEDONIA	
<i>Ivan Boev, Sonja Lepitkova, Blazo Boev</i>	453
КВАЛИТЕТ НА АМБИЕНТАЛЕН ВОЗДУХ- СУСПЕНДИРАНИ ЧЕСТИЧКИ (ПМ-10) ВО ОБЛАСТА ТИКВЕШ	
<i>Иван Боев, Дејан Миравовски, Марија Хаџи Николова, Блажо Боев</i>	459
GEO THERMOBAROMETRIC INVESTIGATIONS OF HERCYNIAN GRANITOIDS OF EAST SERBIA	
<i>Dragana Bosić, Suzana Erić, Kristina Šarić, Bojan Kostić, Vladica Cvetković, Dragan Jovanović</i>	467

MIGRATION OF MICROELEMENTS B, NI, MO, AS, V IN COAL FORMATION SIBOVČ FIELD OF KOSOVO BASIN	
<i>Agim Ymeri, Çerçiz Durmishi, Irakli Prifti, Adil Januzi</i>	469
СЕИЗМОТЕКТОНСКИ ЗОНИ И СЕИЗМИЧКИ ХАЗАРД ВО РЕПУБЛИКА МАКЕДОНИЈА	
<i>Никола Думурианов, Зоран Милутиновиќ, Радмила Шалиќ</i>	477
MAP OF THE MOHO DISCONTINUITY OF THE REPUBLIC OF MACEDONIA	
<i>Todor Delipetrov, Krsto Blazev, Blagica Doneva, Risto Popovski</i>	493
ТЕКТОНСКА РЕОНИЗАЦИЈА И СЕИЗМИЧНОСТ НА РЕПУБЛИКА МАКЕДОНИЈА	
<i>Благоица Донева, Тодор Делипетров, Ѓорѓи Димов, Зоран Панов, Радмила К. Стефановска</i>	497
ПРОЕКТ ЗА ИЗРАБОТКА НА ДИГИТАЛНИ ГЕОФИЗИЧКИ КАРТИ НА РЕПУБЛИКА МАКЕДОНИЈА ВО ГИС ТЕХНОЛОГИЈА СО ТОЛКУВАЧИ	
<i>Новица Столиќ, Ивица Андов</i>	503
НОВИ СОЗНАНИЈА ЗА ГЕОМАГНЕТНОТО ПОЛЕ НА РЕПУБЛИКА МАКЕДОНИЈА	
<i>Марјан Делипетрев, Владимир Маневски, Крсто Блажев</i>	513
МЕТОД НА КОМБИНАЦИЈА НА ГЕО – ЕЛЕКТРИЧНО СОНДИРАЊЕ И КАРТИРАЊЕ	
<i>Владимир Маневски, Марјан Делипетрев, Ивица Коцев, Благој Делипетрев</i>	521
KOENIGSBERGER RATIO AND TOTAL MAGNETIC FIELD ANOMALY REDUCTION TO THE POLE FOR THE AREA OF MACEDONIA	
<i>Vesna Cvetkov, Dragana Đurić, Vesna Lesić, Miroslav Starčević, Mirko Petković, Snežana Petrović</i>	529
2D GEOPHYSICAL MODELS OF DEMIR KAPIJA ORPHOLITE COMPLEX	
<i>Dragana Đurić, Vesna Cvetkov, Ivana Vasiljević, Spomenko Mihajlović, Vladica Cvetković</i>	535
ГРАВИМЕТРИСКИ МРЕЖИ НА РЕПУБЛИКА МАКЕДОНИЈА	
<i>Новица Столиќ, Мирослав Старчевић, Сашио Димески</i>	539
COMPARING GEOMAGNETIC FIELD DAILY ANOMALIES AND GEOSPATIAL SEISMICITY AND ATMOSPHERE DATA IN BALKAN COUNTRIES DURING THE BLACKSEAHAZNET PROJECT	
<i>Milena Cukavac, Strachimir Cht. Mavrodiev, Lazo Pekevski, Spomenko J. Mihajlovic</i>	547

APPLICATION OF IP/RESISTIVITY “REAL SECTION” TECHNIQUE IN SEARCH FOR SULPHIDE MINERALIZATION IN SERBO – MACEDONIAN MASSIF, KOSOVO <i>Përparim Alikaj, Altin Karriqi, Erjon Çollaku</i>	553
ORE MINERALIZATION AT STUDIED GEOMAGNETIC ANOMALIES ON MT. GOLIIJA <i>Jovan Kovačević, Boris Vakanjac, Nikolić Dušan, Mihajlo Pandurov</i>	559
РЕГИСТРАЦИЈА НА ШУМАНОВ РЕЗОНАНС (ПЛ. ПЛАЧКОВИЦА) <i>Лазо Пекевски, Ристо Поповски, Зоран Панов, Страшимир Маџродиев</i>	569

### 3. Геологија и Економија

STRUCTURAL-METALLOGENIC MAP OF THE REPUBLIC OF MACEDONIA: PRINCIPLES AND CRITERIA <i>Todor Serafimovski, Alexandr Volkov, Goran Tasev</i>	573
THE AU/AG RATIO IN EPITHERMAL DEPOSITS <i>Alexander Volkov, Irina Chizhova, Anatoly Sidorov</i>	581
NEW DATA ON THE CENOZOIC VOLCANISM AND ORE MINERALIZATIONS IN THE PETROSHNITSA RIVER VALLEY, NW PART OF THE KRATOVO- ZLETOVO VOLCANIC AREA, REPUBLIC OF MACEDONIA <i>Slavcho Ivanov Mankov, Manol Stoyanov Antonov, Dmytro Rostislavovich Siroshstan, Valentin Yordanov Grozdev</i>	589
CHARACTERISTICS OF CHROMITE MINERALIZATION ON MT. JELICA <i>Predrag Mijatović, Boris Vakanjac, Dragan Jovanović, Božidar Luković</i>	597
3D MODELING OF SOME COPPER DEPOSITS IN THE REPUBLIC OF MACEDONIA <i>Todor Serafimovski, Christos Christidis, Dalibor Serafimovski, Goran Tasev, Mitko Ligorovski, Igor Ivanovski, Lazar Gjorgjiev</i>	605
THE VRSHNIK ORE BODY A POSSITIVE EXAMPLE FOR EXPLORATION, EXPLOITATION AND FILLING IN THE BUCHIM COPPER MINE, EASTERN MACEDONIA <i>Kiril Filev, Todor Serafimovski, Lazar Gjorgjiev, Goran Tasev, Mite Mitev, Metodi Stojanov</i>	613
THE OCCURRENCE OF IRON MINERALIZATION IN VICINITY OF OSTENJAK (ARANDELOVAC), SERBIA <i>Nemanja Pantelić, Bojan Kostić, Predrag Vulić</i>	619

OVERVIEW OF THE NATURAL PARAMETERS FROM THE GEOLOGICAL-ECONOMICAL EVALUATION OF THE BOROV DOL ORE DEPOSIT, REPUBLIC OF MACEDONIA <i>Lazar Gjorgjiev, Todor Serafimovski, Kiril Filev, Goran Tasev</i>	621
COPPER ORECLASTS OF OLISTOSTROME ORIGIN AT BOR, SERBIA <i>Ivan Antonijević</i>	629
РЕЗУЛТАТИ ОД ПРЕЛИМИНАРНИТЕ ПРОСПЕКЦИСКИ ИСПИТУВАЊА НА ЗЛАТО ВО АЛУВИОНОТ НА ПЕКЉАНСКА РЕКА, ВИНИЦА <i>Виолета Стефанова, Марин Александров, Тодор Серафимовски, Горан Тасев, Војо Мирчовски</i>	635
SUPERGENE PROCESSES IN THE COPPER MINERALISATION AT THE KRALJIČIN ZDENAC ON THE MEDVEDNICA MT. <i>Ladislav A. Palinkaš, Danijela Šmajgl, Andreja Čobić, Vladimir Bermanec</i>	643
THE CRVEN DOL ARSENIC-THALIUM MINERALIZATION IN ALSAR DEPOST IN THE REPUBLIC OF MACEDONIA <i>Ivan Boev, Blazo Boev, Sonja Lepitkova</i>	649
PREBAIKAL FORMATION ON THE TERRITORY OF THE REPUBLIC OF MACEDONIA AS SIGNIFICANT BEARERS OF QUARTZ RAW MATERIALS <i>Krsto Blazev, Gorgi Dimov, Blagica Doneva, Marjan Delipetrov</i>	659
GENESIS OF OIL IN THE DEEPEST MIOCENE SOURCE ROCKS IN THE NORTH-WEST PART OF SAVA DEPRESSION <i>Snježana Blažeković Smojić, Vesna Hrženjak, Darko Tomašić, Tamara Troskot-Čorbić, Marina Mužina</i>	665
КВАЛИТАТИВНИ КАРАКТЕРИСТКИ НА АМФИБОЛСКИТЕ ШКРИЛЦИ ОД ЛОКАЛИТЕТОТ “ПОЧИВАЛО“ ИСТОЧНА МАКЕДОНИЈА КАКО ОСНОВА ЗА НИВНА УПОТРЕБА КАКО АРХИТЕКТОНСКО – ГРАДЕЖЕН КАМЕН <i>Орце Спасовски, Даниел Спасовски</i>	675
DIMENSIONAL STONE DEPOSITS IN WESTERN MACEDONIA <i>Ljupche Kulakov</i>	681
МОЖНОСТИ ЗА КОРИСТЕЊЕ НА ОНИКСОТ И ТРАВЕРТИНОТ ОД ЛОКАЛИТЕТОТ ДЕКОВА ДАБИЦА КАКО АРХИТЕКТОНСКИ КАМЕН <i>Орце Спасовски, Даниел Спасовски</i>	689



ТЕКТОНСКАТА ПОВРЗАНОСТ НА РАСЕДНАТА ЗОНА ЖИВОЈНО -БРОД ГНЕОТИНО- СУВОДОЛ <i>Љупчо Петрески, Марија Манева, Анита Мартиновиќ</i>	.....	695
ГЕОЛОШКИ РЕЗЕРВИ НА ЈАГЛЕН ВО ПЕ “РУДНИЦИ”- РЕК БИТОЛА <i>Љупчо Петрески, Елизабета Митревска, Марија Манева</i>	.....	701
ЕНЕРГЕТСКА ПОТЕНЦИЈАЛНОСТ НА БИТОЛСКИОТ ДЕЛ ОД ПЕЛАГОНИСКАТА КОТЛИНА НА ПРОСТОРОТ ПОМЕЃУ СЕЛАТА ЛОЗНАНИ И КАНАТЛАРЦИ НА СЕВЕР И ОРИЗАРИ И НОВАЦИ НА ЈУГ <i>Никола Богатиновски, Стојанче Николов, Петре Пасков</i>	.....	709
MINING / MINERAL SUPPORT SERVICES PROJECT <i>Duška Rokavec, Tina Benda</i>	.....	719

## LORANDITE AND ORPIMENTE FROM EDIT-25 NORTH PART OF ALSHAR DEPOSIT

Ivan Boev, Blazo Boev

*University "Goce Delčev"- Štip, Faculty of Natural and Technical Sciences, Blvd.Krste Misirkov, 10-A,  
P.O.Box 210. 2000 Štip Republic of Macedonia, e-mail: ivan.boev@ugd.edu.mk*

### Abstract

This study presents research conducted on lorandite and orpiment taken from the Adit 25 in the northern part of the Allchar deposit using XRD, ICP-MS, SEM-EDS methods. From the research, it could be concluded that lorandite appears in big monocrystals (up to 1cm) with cherry color and can easily be split. Orpiment also appears in big monocrystals (from 2 to 5 cm). Lorandite always appears on an orpiment with a bit of dolomite basis. From the laboratory testing it can be concluded that those are very pure minerals with composition very near to the stoichiometric minerals.

**Key words:** lorandite, orpiment, Allshar

### INTRODUCTION

The Allchar complex Sb-As-Tl-Au deposit is one of the unique deposits in the world not because of its size, but mineral composition. It contains significant thallium concentrations that classify it as a unique deposit containing that metal. Besides economically significant antimony and arsenic concentrations, the Allchar deposit is the first Carlin-type gold deposit found in the Balkan Peninsula during the mid 1980's.

The latest mining activities started in 1881, and with some interruptions, lasted till 1913 (Janković, 1960). During that period mainly arsenic ore was excavated and exported to Thessaloniki, Greece and Germany. Small amounts were mined out in the outcrops of the deposit. There are no data about the amount of arsenic ore mined out at that time.

The mineral potential of arsenic in the deposit is estimated at some 15.000 tons (Ivanov, 1965). According to today's criteria arsenic is a harmful component that results from antimony processing.

The first results concerning the sulfide minerals from Allchar locality were published by Foullon, 1890, 1892, 1904; Hofmann, 1891; Pelikan, 1891; Goldschmidt, 1896; Hackman, 1897; Stevanovic, 1904).

During the end of the nineteenth (Vrba, 1894; Krener, 1895; Goldschmidt, 1899) and the beginning of the twentieth century (Janasch, 1904; Loczka, 1904; Jezek, 1912, 1913a) the first thallium minerals were discovered (lorandite and vrbaite, respectively) as constituents of arsenic-antimony ore.

Exploration for antimony carried out from 1953 to 1957 and from 1962 to 1965 resulted in the discovery of significant reserves of low grade ore (Ivanov, 1965). However, high arsenic content in Sb-concentrations has precluded economic exploitation. The latest exploration for antimony was carried out in 1970-1973 (Ivanov, 1986).

Mineral potential of the Allchar deposit, both mined out and available ore, exceeds 20.000 tons of antimony with 0.5 % Sb as cut-off grade (Janković et al, 1997).

The name of the deposit pronounces as Allchar, being derived from the names Allatini (a bank institution, owner of the concession) and Charteau (a mining engineer who worked in the mine).

Special interest for thallium as possible solar neutrino detector (Freedman, 1976, 1979) gave a new impulse for systematical investigations of thallium mineralization in the north part of the Allchar deposit (i.e. the Crven Dol ore

### Трет Конгрес на Геолозите на Република Македонија Third Congress of Geologists of Republic of Macedonia

body). This was an international LOREX (LORandite EXperiment) Project aiming to establish reliability of the mineral lorandite from this deposit as thallium solar neutrino detector (Ernst et al., 1984; Pavićević, 1986, 1988, Morinaga, 1986; Pavićević and El Goresy, 1988; Palme et al., 1988; Pavićević and Korschinek, 1993; Anovski, et al, 1993; Frantz et al., 1994; Gržetić, 1993; Hejl et al., 1993; Ivanovski et al., 1993; Lazaru and Stafilov, 1993; Balić Žunić et. al., 1993a, 1993b; Makovicky and Balić Žunić, 1993; Mihajlović, 1993; Mijatović et al., 1993; Petrov and Andonova, 1993; Petrov et al., 1994; Sotirovski and Boyer, 1993; Stafilov et al, 1993, 1994; Trajkovska et al, 1993).

Some adits as no. 21 have been re-opened to enable taking the samples. This activity lasted from 1987 through 1993. Later it was restricted to laboratory investigations.

The mineral potential of thallium in the Allchar deposit has been estimated at 500 tons (order of magnitude) (Ivanov, 1986).

The possible presence of gold in the Sb-As-Tl association at Allchar was initially suggested by different authors (Stafilov, 1985; Ivanov,

1986; Stafilov and Todorovski 1987). During the 1986-1989 period gold mineralization was systema-tically explored. The results of both field and laboratory studies showed that the geological, geochemical, mineralogical and hydrothermal alteration features are strikingly similar to those which characterize Carlin-type mineralization of the Western United States (Percival and Radtke, 1990; Percival et al., 1992).

Unlike the Carlin-type gold deposits in the Western USA, the Allchar mineralization is hosted not only by sediments, but volcanics as well.

It should be emphasized that the Allchar deposit is not fully explored and that the metallogenetic studies are not completed. The current investigations are still in progress.

For the results of previous studies of the Allchar deposit, the reader is referred to Ivanov (1965, 1968); Janković (1960, 1988, 1993); Percival and Boev 1990); Stieglitz (1990); Percival et al. (1992); Percival and Radtke (1994); Boev and Serafimovski (1996); Boev et al., (1993a); Rieck, 1993; Caubel and Galvier (2000).

#### METHODOLOGY

The mineralogical content of the collected samples from Edit 25 was determined using an X-Ray Siemens D 500 equipped with an automated computer and a Cu-monochromatic lamp working at 40 KV and 30 mA. Quantitative analysis of the mineral phases present was performed using the DIFRAC-11 software package and program support by EVAL and IDR.

The values given for the quantitative composition of the analyzed samples represent an average of 3 replicates. For QA and QC of the measurements referent materials and standards from various mineralogical compositions were used: BDS 17385/96 (standard for ore and ore concentrates for X-Ray diffraction quantitative phase analysis), ST SEV 3534-82 (SpS-quartz sand), ST SEV 2981-81 (KN-2, limestone), ST SEV 2980-81 (MpA-copper ore), USZ 47-2008 (granite "MGT-1"). In several cases standard addition method was applied by using some of the

mentioned RM and satisfactory values for the recoveries were obtained.

For the determination of the chemistry of mineralogical phase Cambridge-style SEM stubs using double sided carbon tape, and graphite coated to prevent charging. The coated samples were analyzed by Quanta 650F SEM, fitted with a back-scattered electron detector (BSED) and a Bruker 5030 X-ray detector. The Esprit Quantax 1.9 EDS Analysis System was used to determine the elemental composition of particulate matter. Point Analysis was used to characterize the samples in high-vacuum mode, using an accelerating voltage of 15 kV and a spot size of 6. BSE images of selected fields of view were taken to examine SEM-based characteristics.

The trace elements were determined by the application of ICP-AES while the rest of the elements were determined by ICP-MS. The optimal parameters for both techniques are given in Table 1 and 2, respectively.

**Трет Конгрес на Геолозите на Република Македонија**  
**Third Congress of Geologists of Republic of Macedonia**

**Table 1.** Optimal instrumental conditions for the ICP-AES, Varian Liberty 110

Sample introduction						
atomizer	V-groove					
Atomizer chamber	Inert Sturman-Masters					
Peristaltic pump	12 rollers, 1 turn/min increment					
Conditions for the program						
Power of the plasma	1,0 kW					
Speed of the pump/rpm	25					
Flow of Ar for plasma	15 L/min					
Time for stabilization	30 s					
Flow of axial Ar	1,5 L/min					
Time for washing	30 s					
Pressure of the atomizer	200 kPa					
Time of lagging	30 s					
Background correction	dynamic					
Height of the plasma	Optimal according to SBR					
Conditions of elements						
Element	Wavelength/nm	Plasma height/mm	Slit/nm	Time for integration/s	Filter	Line of grating
Ca	396.847	20	0.02	5	1	1
Mg	279.553	20	0.02	5	6	2
Na	588.995	20	0.02	5	7	1
P	213.618	5	0.007	5	1	3
Fe	259.94	5	0.01	5	6	2
K	766.49	20	0.02	5	7	1

**Table 2.** The optimal instrumental parameters for the ICP-MS, Agilent 7500

Sample introduction			
Atomizer		PEEK, Babington - type	
Atomizer chamber		Glass, doublepass, temperature of the atomizer chamber 2°C	
Injector of ICP torch		Quartz, 2.5 mm	
Conditions of the program			
Power of the plasma		1500 W	
Speed of the pump/rpm		0.1 rps	
Aux flow of Ar for plasma		1.0 L/min	
Carrier gas flow Ar		0.9 L/min	
Sampler cone		nickel	
Skimmer cone		nickel	
Sample depth		7.4	
Points/mass		3	
Time for integration		0,3 s	
Total time for acquisition/ replicates		8 s	
Replicates		3	
Total time for acquisition/ sample		24 s	
Element/mass			
Element	m/z	Element	m/z
Li	7	Sr	88
Be	9	Mo	95
Al	27	Pd	106
Ti	48	Cd	111
V	51	Cs	133
Cr	53	Ba	137
Mn	55	Tl	205
Co	59	Pb	208
Ni	60	Bi	209
Cu	63	Th	232
Zn	66	U	238
Ga	69	Sn	120
Ge	72	Sb	121
As	75		

## RESULTS AND DISCUSSION

Lorandite is world famous mineral described as the first thallium-bearing mineral. Since its first discovery in Allchar in 1884 (Krenner, 1894, 1895, 1897) its smaller quantities have been found in only a few other localities worldwide. The monoclinic tabular aggregates of lorandite are typically dispersed throughout realgar and orpiment hosts. Well-developed crystals are much more seldom. They show many different forms. Krenner (1895), Goldschmidt (1899) and Barić (1958) described up to 32 forms. Lorandite can easily be distinguished from realgar by its darker red color, its semimetallic luster and its perfect cleavage on (001) (201) and (110). Some crystals are coated by a brownish yellow crust. Lorandite crystals of 1 cm are typical for this locality, although exceptionally single crystals up to 5 cm in size have been found. Lorandite is named after the Hungarian physician Lorand Eötvös (1848-1919).

Chemical composition of lorandite has been well established (Jannasch, 1904). The investigations in connection with the LOREX program have revealed some interesting features. The Allchar lorandite is pure, containing only traces of K, Cr, Fe, Cu and Zn (Palme et al., 1988). The ore-grade in the richest zone contains about 18,000 cubic meters of ore with an average Tl content of 0.35 %. Microprobe analyses in the recent investigations show presence of Hg.

Palme et al. (1988) described orpiment as a stoichiometrically rather pure mineral, although it does contain traces of K, Cl, Cr, Mn, Fe and Cu. It occurs mainly as compact masses sometimes weighing several hundred kilograms. Bright yellow, elongated idiomorphic crystals with adamantine luster faces are very rare. Orpiment usually forms fan-shaped aggregates or hemispheres, mainly having brownish yellow color and dull luster. The crystal size of a few mm is typical. The presence of lorandite near the realgar and orpiment zones is observed.

Chemical composition of pure lorandite and orpiment by ICP-MS are presented in the Table 3. In Table 4 and 5 are presented the chemical composition of pure lorandite and orpimente by SEM-EDS (Fig.1,2).

**Table 3.** Geochemical analyses of orpiment and lorandite from the edit 25 In Alshar deposit (by ICP-MS)

	Orpiment	Lorandite
	mg/kg	mg/kg
Tl	234	602999
As	<b>604620</b>	195996
Hg	<0,1	10
Sb	993	0,176
Li	<0,086	0,125
Be	<0,086	<0,054
Na	43	24
Mg	49	22
Al	74	7,8
P	6,32	1,72
K	<86	<54
Ca	<86	<54
Ti	14,1	3,4
V	2,4	0,68
Cr	7,09	2,24
Mn	2,43	1,03
Fe	140	6,42
Co	0,15	<0,054
Ni	1,43	0,11
Cu	1,151799	0,170305
Zn	0,087378	0,1217
Ga	0,20	<0,054
Ge	0,09	<0,054
Se	3,5	0,95
Rb	0,25	<0,054
Sr	0,61	0,084
Mo	0,66	0,113
Pd	0,77	<0,054
Ag	0,110	<0,054
Cd	0,103	0,501
Sn	0,353	0,408
Cs	<0,086	<0,054
Ba	5,22	0,051
Pb	9,24	0,327
Bi	<0,086	<0,054
Th	0,251	<0,054
U	0,060	<0,054

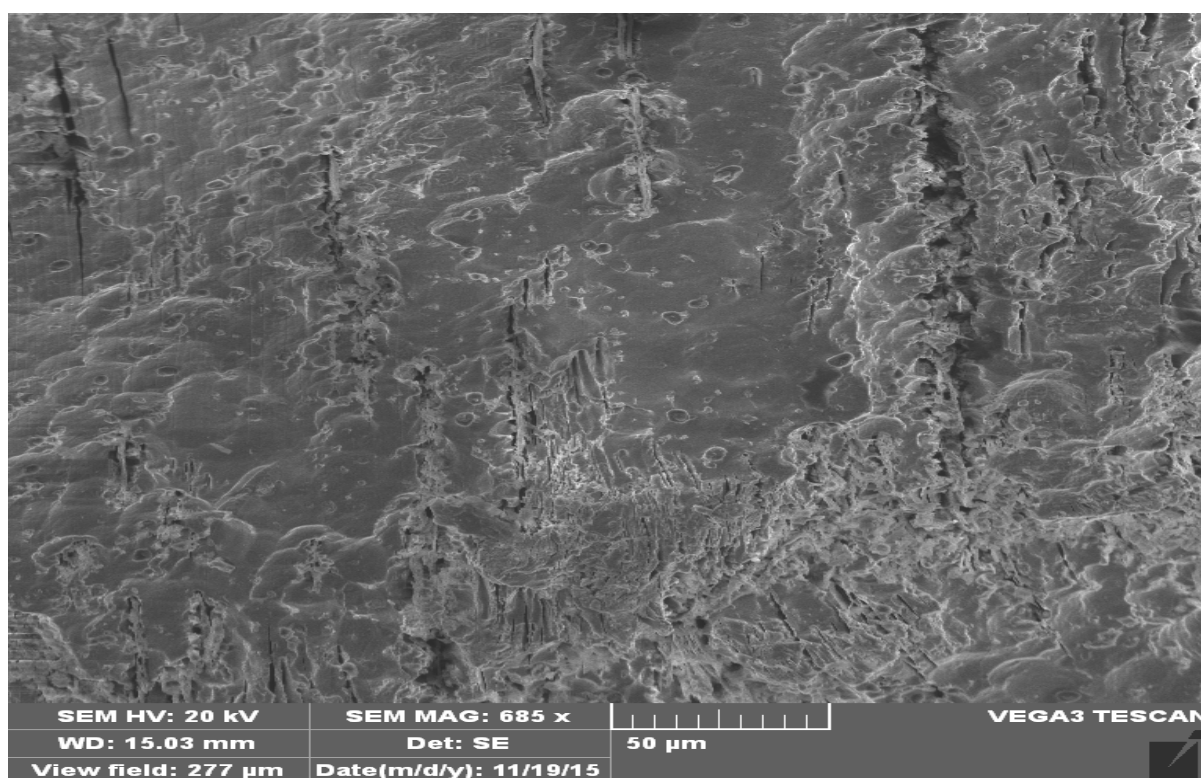
**Трет Конгрес на Геолозите на Република Македонија**  
**Third Congress of Geologists of Republic of Macedonia**

**Table. 4** Chemical composition of orpiment by the SEM-EDS

Orpiment SEM-EDS	
As %	S %
59.77	40.23
60.31	39.69
59.69	40.31
58.43	41.57
61.01	38.99
62.23	37.77
58.54	41.46
60.52	39.48

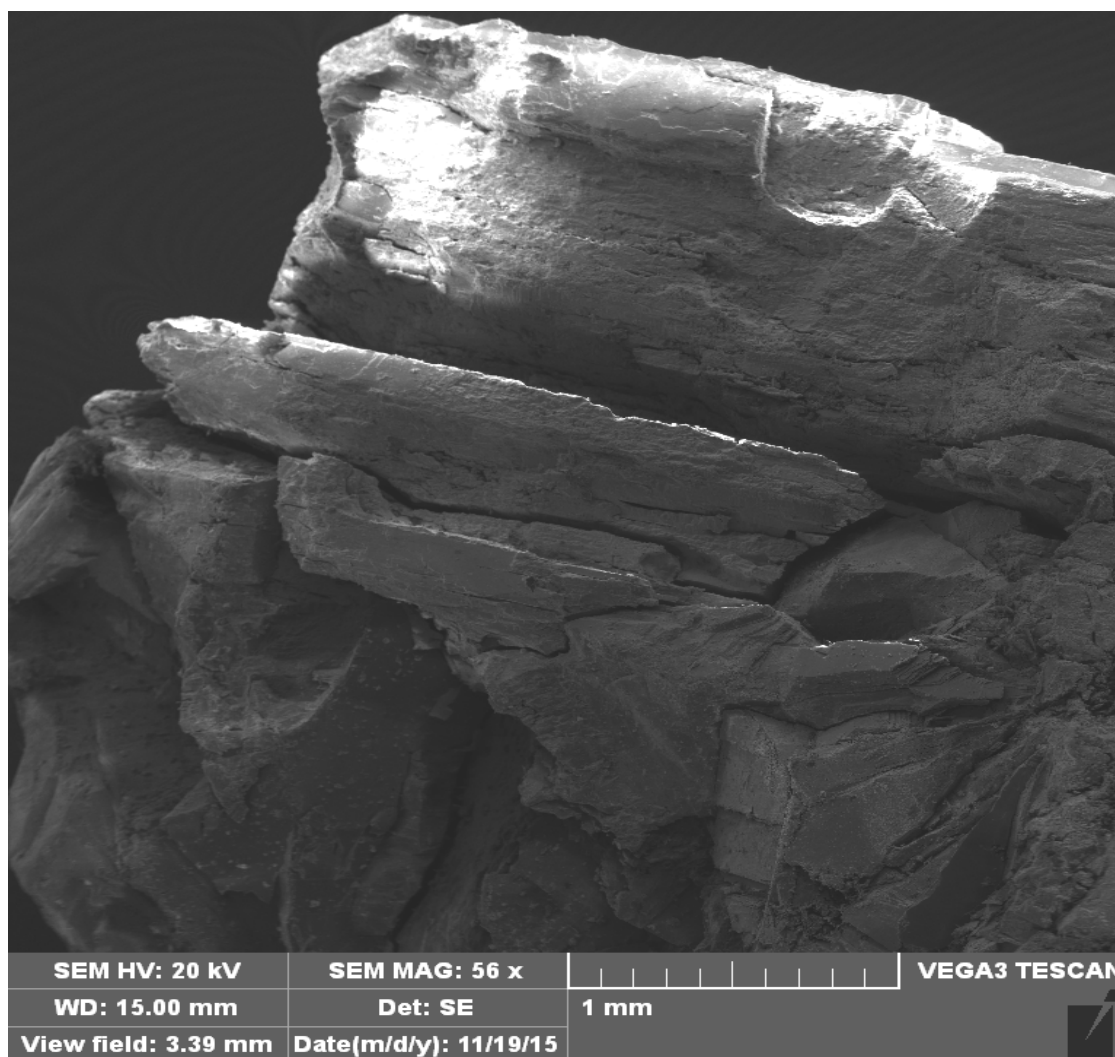
**Table. 5** Chemical analysis of lorandite from edit 25 by SEM-EDS

Tl %	As %	S %
59.01	21.7	19.29
58.78	22.01	19.21
60.07	21.5	18.43
58.23	22.42	19.35



*Fig. 1 Orpiment from edit 25 in Allshar deposit under the SEM*





*Fig. 2 Lorandite from edit 25 in Allshar deposit under the SEM*

## CONCLUSIONS

In the final sections of the Adit 25 in the Allchar deposit on 750 meters distance from the entrance there is a zone with hydrothermally altered dolomites with impregnated orpiment and lorandite

occurrence (desiminated). The investigation on orpiment and lorandite samples using the ICP-MS and SEM-EDS methods suggest pure minerals with composition very near to the stoichiometric minerals.

## REFERENCES

- Anovski, T., Cvetanovska, L., Geršanovski, D., Popov, V., 1993: Gamma spectrometric determination of uranium and thorium in Allchar ore and mineral samples. *Geologica Macedonica*, 7, 31-33.
- Balić Žunić, T., Makovicky, E., 1993a: Contributions to the crystal chemistry of thallium sulphosalts I. The O-D nature of imhofite. *N. Jb. Miner. Abh.*, 165, 3, 317-330.
- Balić Žunić, T., Stafilov, T., Tibljaš, D., 1993b: Distribution of thallium and the ore genesis at the Crven Dol locality in Alšar. *Geologica Macedonica*, 7, 45-52.
- Barić, Lj., 1958: Neuuntersuchungen des Loranditvorkommens von Mazedonien Vergleich der Mineralvergesellschaftungen in den beiden bisher unbekannten Fundorten des Lorandits. *Schweizer Miner. Petrogr. Mitt.*, 38, 247-253.
- Boev, B., Stojanov, R., Denkovski, G., 1993a: Geology of Alshar polymetallic deposit, Macedonia. *Geologica Macedonica*, 7, 35-39.
- Boev, B., Serafimovski, T., Milosavljević, B., 1993b: Trace elements in some minerals from Alshar deposit. *Geologica Macedonica*, 7, 41-43.

### Трет Конгрес на Геолозите на Република Македонија Third Congress of Geologists of Republic of Macedonia

- Boev, B., Serafimovski, T., 1996: General genetic model of the Allchar deposit. Plate Tectonic Aspects of the Alpine Metallogeny in the Carphato Balcan Region. Proceedings of the Annual Meeting of IGCP Project 356, Vol. 1, 75-85, Sofia.
- Caubel, A., Galvier, J., 2000: Le thallium, ses minéraux, son utilisation, Regne Mineral, 32, 31-43.
- Ernst, H., Korschinek, G., Kubik, P., Mayer, W., Morinaga, H., Nolte, E., Ratzinger, U., Henning, W., Kutschera, W., Muller, M., Schull, D., 1984: 205Pb Accelerator mass spectrometry of a very heavy radioisotope and the Solar neutrino problem. Nucl. Instr. Meth. Phys. Res., B5, 426-429.
- Foullon, H. von, 1890: Über Antimonit und Schwefel aus Macedonien. Verhdlg. d. k. k. geol. Reichsanstalt. Wien, 318.
- Foullon, H. von, 1892: Schwefel und Realgar von Allchar. Verhdlg. Reichsanstalt, 171.
- Foullon, H. von, 1894: Realgar von Allchar in Macedonien. Z. Krystallogr., 39, 113-121.
- Frantz, E., Palme, H., Todt, W., El Goresy, A., Pavičević, M. K., 1994: Geochemistry of Tl-As minerals and host rocks at Allchar (Macedonia). N. Jb. Miner. Abh., 167:359-399.
- Freedman, M. S., Stevens, C. M., Horwith, E. D., Fuchs, H., Lerner, J. S., Childs, W. J., Hessler, J., 1976: Solar Neutrinos, proposal for a new test. Science, 193, 1117-1118.
- Freedman, M. S., 1979: Tl as a low energy neutrino detector, Proceedings of the Informal Conference on the Status and Future of Solar Neutrino Research, Editor; G. Frieland, 1, RNL 50879, 313-360.
- Goldschmidt, V., 1896: Realgar von Allchar. Beispiel der Discussion eines Projektionsbildes. Z. Krystallogr., 25, 553-555.
- Goldschmidt, V., 1899: Über Lorandit von Allchar in Macedonien. Z. Krystallogr., 30, 272-294.
- Gržetić, I., 1993: Thallium sulphosalts and their phase diagrams related to natural mineral occurrences. Geologica Macedonica, 7, 61-68.
- Hackman, V., 1897: Ueber eine neue Form am Realgar von Allchar in Macedonien. Z. Krystallogr., 27, 608-609.
- Hejl, E., Pavičević, M. K., 1993: Evaluation of long - term erosion rates at the Allchar deposit by fission - track dating of apatites, Geologica Macedonica, 7, 9.
- Hofmann, R., 1891: Antimon - und Arsen-Erzbergbau "Allchar" in Macedonien. Öst. Zeitsch. Berg., 39, 167-173.
- Ivanov, T., 1965: Zonal distribution of elements and minerals in the deposit Allchar. Symp. Problems of Postmagmatic Ore Deposition, II, 186-191, Prague.
- Ivanov, T., 1986: Allchar the richest ore deposit of Tl in the world. Proceedings on The Feasibility of the Solar Neutrino Detection with 205Pb by Geochemical and Accelerator Mass Spectroscopical Measurements, GSI-86-9, Darmstadt, 6 pp.
- Ivanovski, G., Mijatović, M., Veljanovski, B., 1993: Bound states of a neutral nonrelativistic and relativistic particle with spin - 1/2 in a magnetic field. Geologica Macedonica, 7, 25-29.
- Janković, S., 1960: Allgemeine Charakteristika der Antimonit Erzlagerstätten Jugoslawiens. N. Jb. Miner. Abh., 94, 506-538.
- Janković, S., 1988: The Allchar Tl-As-Sb Deposit, Yugoslawien and its specific metallogenic features. Nucl. Instr. Meth. Phys. Res., A271, 286.
- Janković, S., 1993: Thallium mineralization in the Alšar complex Sb-As-Tl-Au deposit. Geologica Macedonica, 7, 53.
- Jankovic, S., Boev, B., Serafimovski, T., 1997: Magmatism and Tertiary Mineralization of the Kozuf Metallogenic District, the Republic of Macedonia with Particular reference to the Allchar Deposit. Faculty of Mining and Geology, Štip, Special Issue No. 5, 262.
- Jannasch, P., 1904: Analyse des Lorandit von Allchar. Z. Krystallogr., 39, 122-124.
- Ježek, B., 1912: Sur la vrbaite, un nouveau minérale du thallium d'Allchar en Macédoine. Bull. Int. Acad. Sci. Bohème, 1-12.
- Ježek, B., 1913a: Vrbait, ein neues Thalliummineral von Allchar in Macedonien. Z. Krystallogr. Miner., 51, 365-378.
- Krenner, J. A., 1894: Lorandit, ein neues Thallium-Mineral von Allchar in Macedonien. Math. es term. tud. Ertesitö, 12, 473.
- Krenner, J. A., 1895: Lorandit, ein neues Thallium-Mineral von Allchar in Macedonien. Math. es term. tud. Ertesitö, 13, 258-263.
- Krenner, J. A., 1897: Lorandit, ein neues Thallium-Mineral von Allchar in Macedonien, Z. Krystallogr., 27, 98-99.
- Lazaru, A., Stafilov, T., 1993: Determination of Fe, Mn, Cu, Cr and Ni in some minerals from the Alšar mine by atomic absorption spectrometry. Geologica Macedonica, 7, 73-80.
- Loczka J., 1904: Chemische Analyse des Lorandit von Allchar in Macedonien und des Claudetit von Szomolnok in Ungara. Z. Krystallogr., 39, 520-525.
- Makovicky, E. Balić Žunić, T., 1993: Contributing to the crystal chemistry of thallium

### Трет Конгрес на Геолозите на Република Македонија Third Congress of Geologists of Republic of Macedonia

- sulphosalts. II. TlSb<sub>3</sub>S<sub>5</sub> - the missing link of the lillanite homologous series. N. Jb. Miner. Abh., 165, 3, 331-344.
- Mihajlović, D., 1993: Preparation of samples taken from the Alshar mine for x-ray fluorescence spectrometry. *Geologica Macedonica*, 7, 69-72.
- Mijatović, M., Ivanovski, G., Veljanovski, B. Apostolovska, G., 1993: Tunneling of a neutral nonrelativistic and relativistic particle with spin - 1/2 through magnetic field. *Geologica Macedonica*, 7, 11-24.
- Morinaga, H., 1986: The problem of transition rates. Workshop on the Feasibility of Solar Neutrino Detection with 205Pb by Geochemical and AMS Methods, Editor E. Nolte, GSI Report, 86-9, Darmstadt.
- Palme, H., Pavičević, M. K., Spettel, B., 1988: Major and trace elements in some minerals and ore from Crven Dol, Allchar. *Nucl. Instr. Meth. Phys. Res.*, A271, 314-319.
- Pavičević, M. K., 1986: International Conference on Solar Neutrino Detection with 2-05Tl, Program and Abstract Book, p. 21, Dubrovnik.
- Pavičević, M. K., 1988: Lorandite from Allchar-A low energy solar neutrino dosimeter. *Nucl. Instr. Meth. Phys. Res.*, A271, 287-296.
- Pavičević, M. K., El Goresy, A., 1988: Crven Dol Tl deposit in Allchar: Mineralogical investigations, chemical composition of Tl minerals and genetic implications. *Nucl. Instr. Meth. Phys. Res.*, A271, 297-300.
- Pavičević, M. K. Korschinek, G., 1993: Determination of erosion - rates by means of 26Al in the area of Crven Dol (Allchar), *Geologica Macedonica*, 7, 10.
- Pelikan, A., 1891: Schwefel von Allchar in Macedonien. *Tscherm. Min. Mit.*, 12, 344-345.
- Percival, T.J., Radtke, A., 1990: Carlin Type Gold Mineralization in the Allchar District, Macedonia, Yugoslavia. Eight IAGOD Simp. Ottawa, Canada, 1990. Program with Abstracts, P.A. 108
- Percival, T., Boev, B. 1990: As-Tl-Sb-Hg-Au-Ba Mineralization, Allchar District, Yugoslavia; A Unique type of Yugoslavian Ore Deposit. Int. Symposium On Solar Neutrino Detection with 205Tl., Yug. Soc. Nucl. Elemen. Pert. Phys., Dubrovnik, Abstract, 36-37.
- Percival, T., Radtke, A., Jankovic, S., Dickinson, F., 1992: Gold Mineralization of the Carlin type in the Allchar District, Macedonia. In Y. T. Maurice, ed., *Proceedings on Eight IAGOD Symposium*, Ottawa, E. Schweizerbartische Verlag, 637-646, Stuttgart.
- Percival, T., Radtke, A., 1994: Sedimentary Rock-hosted disseminated Gold Mineralization in the Allchar District, Macedonia. *Cand. Mineralogist*, 32, 649-655.
- Petrov, B. Andonova, D., 1993: Possibility of concentration of ore minerals from the Allchar ore deposit, Crven Dol locality, horizon 800, *Geologica Macedonica*, 7, 82.
- Petrov, B., Andonova, D. Stafilov, T., Novakovski, T., 1994: Possibility of concentrating the thallium mineral lorandite from the Allchar deposit, Crven Dol region. N. Jb. Miner. Abh., 167: 413-420.
- Rieck, B., 1993: Allchar, Macedonia. *Miner. Record*, 24, 437-448.
- Sotirovski, P., Boyer R., 1993: The sun and solar neutrinos, *Geologica Macedonica*, 7, 1-8.
- Stafilov, T. 1985: Representation of some rare and noble metals in arsenic-antimony ore from Alšar mine and the possibility of their concentration, PhD Thesis, Faculty of Science, Skopje (in Macedonian).
- Stafilov, T., Todorovski, T., 1987: Determination of gold in arsenic-antimony ore by flameless atomic absorption spectrometry. *At. Spectrosc.*, 8, 12-14.
- Stafilov, T., Aleksovska, S., Jordanovska, V., 1993: Determination of lead in some sulfidic minerals from Alshar, *Geologica Macedonica*, 7, 81.
- Stafilov, T., Lazaru, A., Pernicka, E., 1995: Determination of silver in sulfide minerals by electrothermal atomic absorption spectrometry. *At. Spectrosc.*, 16, 158-161.
- Stevanovic, S., 1904: Auripigment von Allchar in Macedonien. *Z. Krystallogr.*, 39, 14-18.
- Stieglitz, H., 1990: Abenteuer Allchar. *Lapis*, 15(2), 11-19.
- Trajkovska, M., Šoptrajanov, B., Stafilov, T. Jovanovski, G., 1993: Determination of lorandite and realgar in mineral using infrared spectroscopy, *Geologica Macedonica*, 7, 55-59.
- Vrba, K., 1894: O nekterych mineralech z Allcharu v Macedonii, *Vestnik kr. České Spol. Nauk, tr. math. prir. pojedn.*, 48.